West Branch Sheepscot River
Total Maximum Daily Load (TMDL)

Draft Report

Below Maxcy's Mills Road, Windsor (8/2004)

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ACRONYMS USED

BMP	Best Management Practice
DO	Dissolved Oxygen
KCSWCD	Kennebec County Soil and Water Conservation District
MDEP	Maine Department of Environmental Protection
NRCS	Natural Resources Conservation Service
NPS	Nonpoint source
SRWC	Sheepscot River Watershed Council
SVCA	Sheepscot Valley Conservation Association
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TN	Total Nitrogen
USEPA	United States Environmental Protection Agency

1. DESCRIPTION OF WATERBODY, POLLUTANT OF CONCERN, POLLUTANT SOURCES AND PRIORITY RANKING

Description of Waterbody and Watershed

The West Branch Sheepscot River (West Branch for short; Fig. 1) is a first through third order stream/river that originates above Branch Pond in the town of Palermo, Waldo County, Maine. Past Branch Pond, the West Branch flows in a southerly direction through the towns of China, Windsor (Kennebec County), and Whitefield (Lincoln County) where it flows into the Sheepscot River, which ultimately drains into the Gulf of Maine. The river is 15 miles long and has a watershed size of 32,400 acres or ~51 square miles. The gradient ranges from low to moderate with some natural deadwater areas. The substrate is dominated by boulders, cobble, and gravel with small amounts of sand. Landuse in the watershed is a rural mix of forested areas and agriculture with sparse residential development along the major roadways. In terms of water classification, the headwaters of the West Branch above Branch Pond are classified as Class B, and the section from the outlet of Branch Pond to the confluence with the Sheepscot River as Class AA (see section 2., below).

The Sheepscot River, including the West Branch, is one of eight Maine rivers that support populations of the endangered Atlantic salmon (*Salmo salar*). Observed reductions in population size have been in part attributed to nonpoint source pollution, which can affect salmon and other aquatic organisms in two main ways. First, nutrient enrichment from agricultural and road runoff can cause excessive algae growth which will lead to a depletion of dissolved oxygen in the water. Second, sediment runoff from roads or erosional areas can degrade habitat by filling in gravel substrate (KCSWCD 2005a).

Data collected since 1994 by a regional land trust, the Sheepscot Valley Conservation Association (SVCA), showed that dissolved oxygen (DO) levels in the West Branch often fall below a level of 7 mg/L (see next section). On occasion, levels fall below 6 mg/L, which is considered not suitable for salmonids (Dill et al. 2002). Furthermore, phosphorus levels have exceeded the criterion recommended by EPA for Ecoregion VIII, which includes the West Branch. A 1996 survey by the Natural Resources Conservation Service (NRCS) showed that there were ~870 cattle and 35 horses in the West Branch watershed. This number has declined in the last few years as some dairy farms have closed (D. Desrosier, NRCS Kennebec County, pers. comm.). The survey also showed that ~3 % of cropland, hayland or pasture (1,062 acres of 32,512 acres total) were separated from the stream by a less than 100 foot-wide riparian buffer. Nutrient sources in addition to livestock and agricultural lands include roadways, gravel pits, residential development, and timber harvesting.

In 1999, the Kennebec County Soil and Water Conservation District (KCSWCD) began a three-phase project to restore water quality in the West Branch (KCSWCD 2003, 2005). Phases 1 and 2 were completed in October 2003 and January 2005, respectively. Major project tasks were water quality monitoring performed by the SVCA, identification of water quality problem sites, education and outreach, and implementation of Best Management Practices (BMPs) to address a range of nonpoint source (NPS) pollution issues. A total of 55 sites with known water quality issues were addressed in Phases 1 and 2; the majority of these

were related to roads but some agricultural and riparian buffer issues were addressed as well. Estimates showed that sediment pollution from 27 sites was reduced by 72,000 lb/yr (KCSWCD 2005a). Phase 3 of the project, which will run from May 2006 to December 2007, will address 15-20 additional road sites, provide education and training to towns and residents, and continue water quality monitoring performed by the SVCA (KCSWCD 2005b). Currently (May 2004 to early summer 2006), the KCSWCD is coordinating the development of a Watershed Management Plan for the entire Sheepscot River watershed (Time and Tide RC&D 2004). This project includes NPS surveys, watershed characterization, water quality assessment, development of watershed goals, outreach efforts, and development and distribution of the watershed management plan. A concurrent project (March to December 2005) led by the KCSWCD provides roads and runoff training to towns located in the West Branch watershed (KCSWCD 2005c). The Sheepscot River Watershed Council (SRWC) is in the process of developing a comprehensive plan for the Sheepscot River watershed (L. Krajewski, SRWC, pers. comm.). This plan will provide a road map for future action in the watershed as spearheaded by the SRWC.

Descriptive Land Use Information

Figure 2 shows the distribution of landuse types throughout the watershed. Landuse descriptions were derived from 'Maine_Combo_Landcover', a GIS map layer developed by MDEP staff that combines data from Maine Gap Analysis (GAP) and USGS Multi Resolution Landcover Characterization (MRLC) coverages. Both MRLC and GAP are based on 1992 LandSat TM satellite imagery and the metadata for Maine_Combo_Landcover are maintained by MDEP's GIS Unit. Table 1 and Figure 2 clearly show the domination of forests followed by grasslands with small amounts of other landuse types. Although forests are the largest landuse type, agricultural landuses (pastures and fields) occur along several stretches directly adjacent to the river, especially in the lower part of the watershed (Fig. 3).

Table 1. Extent of landuse types in the West Branch Sheepscot River watershed.

Landuse Type	Area (acres)	%
Forest	19,885	61.2
Grassland / Peatland	5,551	17.1
Wetland	2,260	7.0
Clear / Partial Cuts	1,189	3.7
Shrub-scrub	1,158	3.6
Cropland	697	2.2
Water	684	2.1
Residential	570	1.8
Abandoned Field	292	0.9
CIT* - Highways	114	0.4
Total	32,399	100.0

* CIT, Commercial-Industrial-Transportation

Figure 1. West Branch Sheepscot River watershed with impaired segment and sampling stations (Sheepscot Valley Conservation Association, SVCA; MDEP biomonitoring).

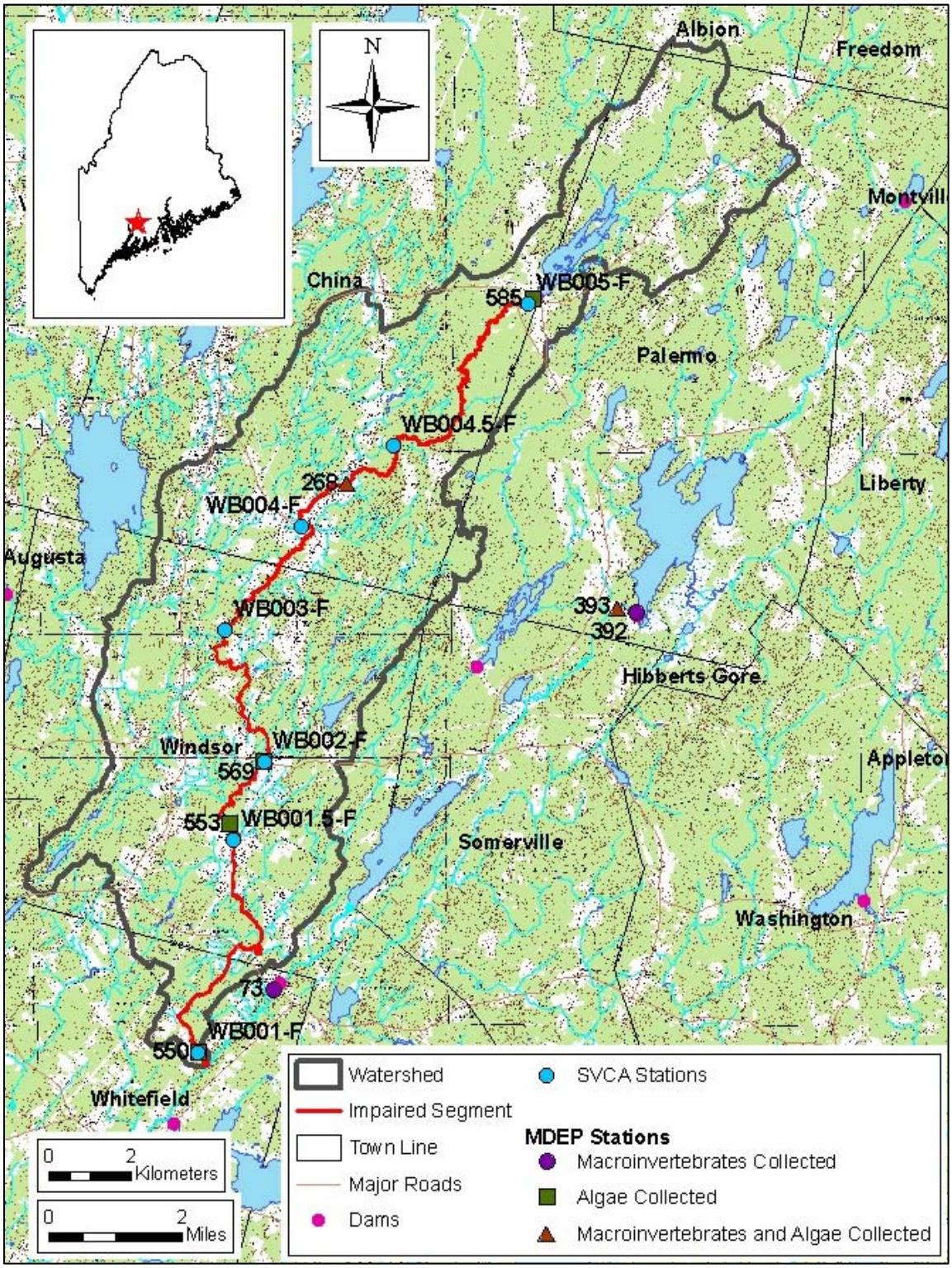


Figure 2. West Branch Sheepscot River landuse map. CIT, Commercial-Industrial-Transportation

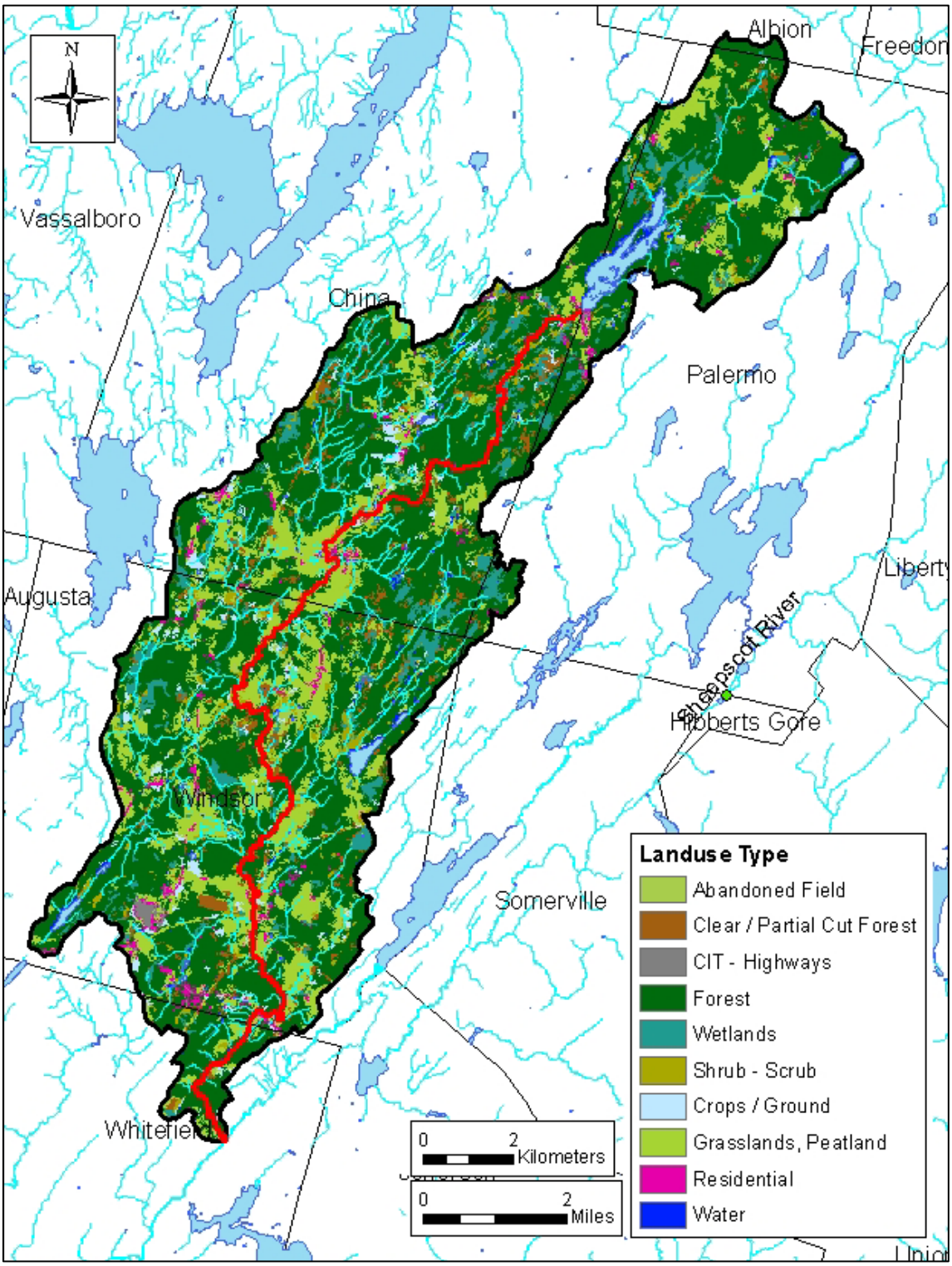
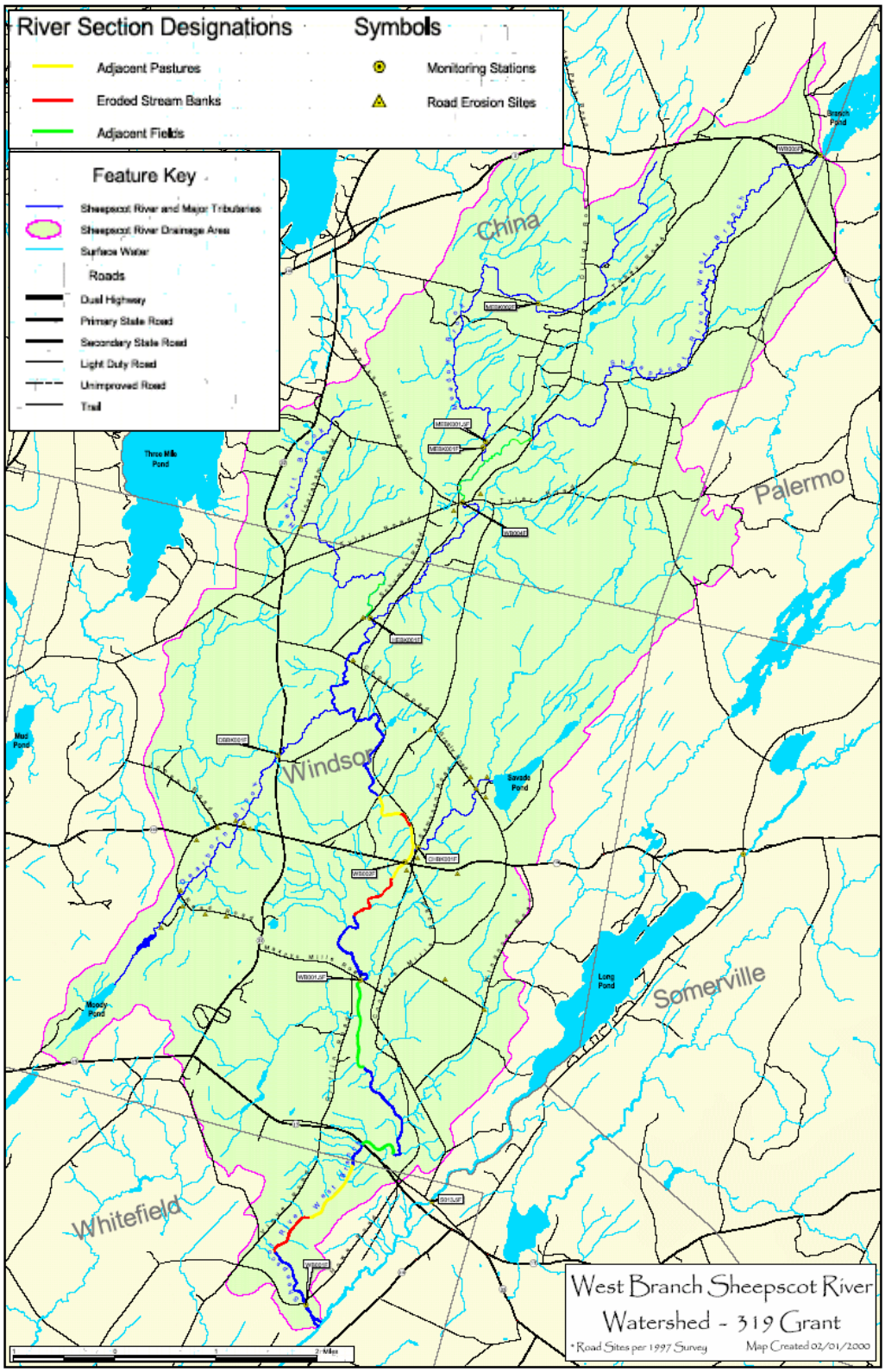


Figure 3. Pastures and fields along the West Branch Sheepscot River. (Map produced by the KCSWCD and used here by permission.)



Pollutant Sources, Description of Impairments, and Sampling Results

The West Branch Sheepscot River is impaired by nonpoint source runoff from anthropogenic activities and development within the watershed. All land disturbances have the potential to contribute runoff, but the degree of disturbance associated with ongoing farming and animal production operations may be a significant contributor of nutrient enrichment. No point sources were identified in the watershed.

The dissolved oxygen (DO) concentration for Class AA streams is required to be 'as naturally occurs' (see section 2.). For the purposes of determining a violation of water classification standards, the standard for Class B streams, i.e. 7 mg/L, is used here. Violations of this standard have been documented by a regional land trust, the Sheepscot Valley Conservation Association (SVCA), which has been collecting data at a total of seven sites (Fig. 1) for up to eleven years, beginning in 1994 (Table 2). Results showed that early-morning DO levels in the West Branch fall below 7 mg/L on 6 to 54 % of the sampling dates, depending on site (Table 2). Levels below 6 mg/L, which are considered not suitable for salmonids (Dill et al. 2002), were found on occasion, occurring on 0 to 26 % (average of 8.2 %) of the sampling dates depending on site. Plots of raw data show that low DO values are largely limited to the summer months (Appendix A).

Table 2. Dissolved Oxygen (DO) monitoring results from Sheepscot River Conservation Association (SVCA).

Site (upstream to downstream)		**Number of**		
SVCA ID	**Location**	**Sampling years**	**DO measurements**	
			all	**<7 mg/L (% of total, range)**
WB005-F	Outlet of Branch Pond	10 (1995-2004)	115	46 (40 %, 4.2-6.9)
WB004.5-F	Above Dirigo Road	5 (2000-2004)	56	15 (27 %, 5.8-6.8)
WB004-F	Below Tyler Road	10 (1995-2004)	106	12 (11 %, 6.1-6.9)
WB003-F	Below Choate Road	3 (1994-1996)	34	18 (53 %, 4.2-6.8)
WB002-F	Above Rt. 105	10 (1994-1996, 1998-2004)	113	54 (48 %, 4.4-6.9)
WB001.5-F	Below Maxcy's Mills Road	9 (1996-2004)	85	38 (45 %, 5.0-6.9)
WB001-F	Below Howe Road	11 (1994-2004)	108	6 (6 %, 5.9-6.9)

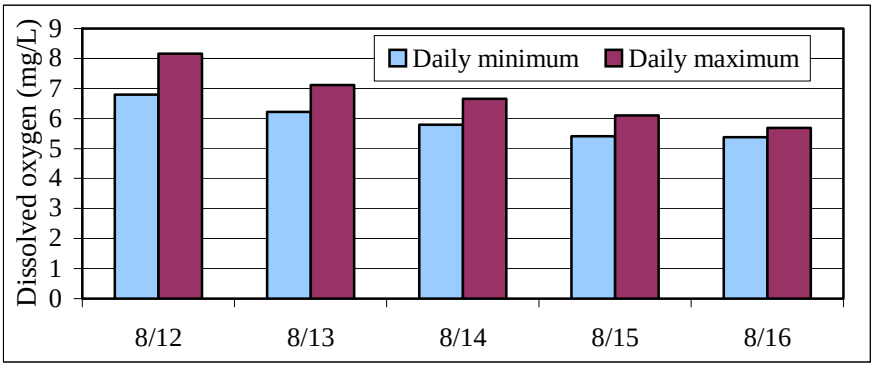
Dissolved oxygen levels also were measured by MDEP for five days in early August 2004 with continuous monitoring equipment (YSI datasonde). Violations of the 7 mg/L standard were consistently measured at three upstream sites while the most downstream site met DO standards (Table 3, Fig. 4). The downstream site is also the site that showed the fewest violations according to the SVCA's data (Table 2). A difference of 2 mg/L or greater between the daily minimum and maximum values is considered an indicator of nutrient enrichment (P. Mitnik, MDEP, pers. comm.). Such a difference was only found on one date

at one site (8/12, above Rt. 17; Table 3) suggesting that excessive algal growth is a not major factor in causing low DO concentrations in early morning.

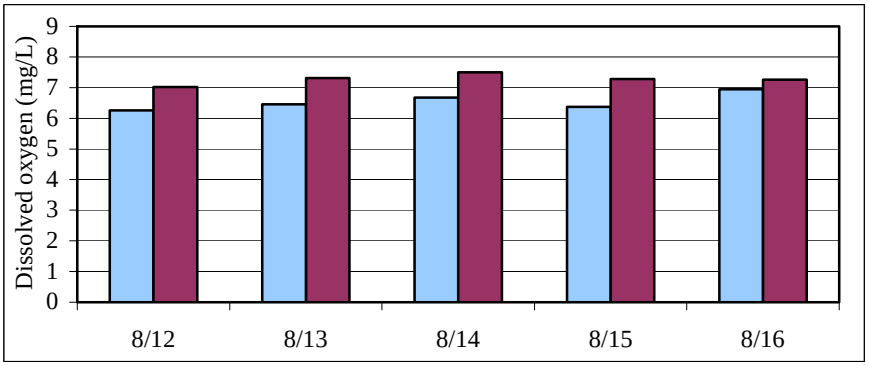
Table 3. Dissolved oxygen and temperature data from MDEP from continuous monitoring in 2004 (upstream to downstream). Dissolved oxygen violations (< 7 mg/L) are highlighted.

Date	DO (mg/L)		Temperature (ºC)	
	Minimum	Maximum	Minimum	Maximum
Above Dirigo Road (SVCA --, MDEP S268)				
12-Aug	6.8	8.2	20.0	22.1
13-Aug	6.2	7.1	19.8	20.9
14-Aug	5.8	6.7	19.7	23.0
15-Aug	5.4	6.1	19.6	21.3
16-Aug	5.4	5.7	19.0	20.7
Above Rt. 105 (SVCA WB002-F, MDEP S569)				
12-Aug	6.3	7.0	21.5	22.3
13-Aug	6.5	7.3	20.2	22.0
14-Aug	6.7	7.5	19.9	22.6
15-Aug	6.4	7.3	20.1	22.3
16-Aug	7.0	7.3	19.0	20.1
Above Rt. 17 (--)				
12-Aug	5.7	8.1	20.4	22.2
13-Aug	5.9	7.1	19.0	21.2
14-Aug	5.7	6.7	19.3	21.8
15-Aug	5.5	6.0	19.6	21.2
16-Aug	5.6	6.1	18.6	19.6
Above Howe Road (SVCA WB001-F, near MDEP S550)				
12-Aug	7.5	8.5	21.2	23.3
13-Aug	7.4	7.8	19.9	22.1
14-Aug	7.6	8.0	20.0	22.2
15-Aug	7.5	8.0	20.4	21.9
16-Aug	7.8	8.2	19.7	20.4

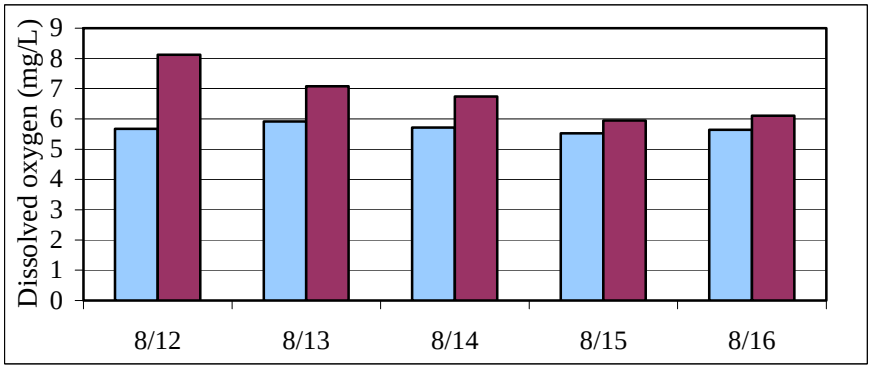
Figure 4. Dissolved oxygen data from MDEP from continuous monitoring in 2004 (upstream to downstream).



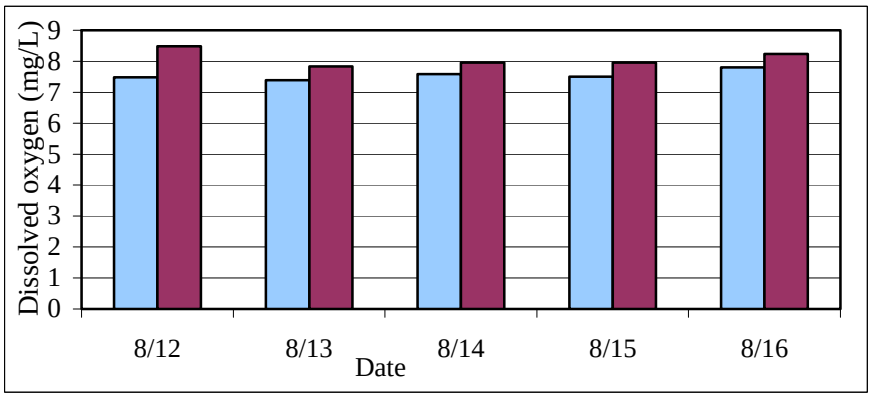
Above Dirigo Road



Above Rt. 105



Above Rt. 17



Above Howe Road

Since Maine does not have a water quality standard for nutrients, Total Phosphorus (TP) and Total Nitrogen (TN) data were compared to the criteria recommended by EPA for waters in Ecoregion VIII, which includes the West Branch. Baseflow data showed that the recommended value of 0.01 mg/L TP was exceeded in most sampling events while stormflow data showed fewer violations (Table 4). For TN, only baseflow data are available, and the EPA-recommended criterion was exceeded in all sampling events (Table 4). Further evidence of nutrient enrichment is found in Chlorophyll *a* (Chl *a*) data collected in August 2004 throughout the watershed (seven sites from the Branch Pond outlet to Howe Road). Values ranged from 0.0015 to 0.0060 mg/L, clearly exceeding EPA's recommended Chl *a* level for Ecoregion VIII of 0.00063 mg/L. Nutrient loadings from nonpoint sources are likely a major contributor to the DO impairment and sources include eroded soils, fertilizer, fecal matter from livestock, and organic material associated with anthropogenic activities.

Table 4. Total Phosphorus (TP) and Total Nitrogen (TN) monitoring results from MDEP.

Site (upstream to downstream)		**Number of**					
			TP measurements			**TN measurements**	
MDEP ID	**Location**	**Sampling years**	**all**	**>0.01 mg/L (% of total, range)**	**Sampling years**	**all**	**>0.38 mg/L (% of total, range)**
Baseflow sampling							
S585	Outlet of Branch Pond	3 (1999, 2000, 2002)	9	8 (89 %, 0.013-0.023)	1 (2000)	1	1 (100 %, 0.43)
S268	Above Dirigo Road	4 (2001-2004)	9	6 (67 %, 0.011-0.019)	4 (2001-2004)	6	6 (100 %, 0.42-0.55)
-- (near S569)	Above Rt. 105 (above Choate Brook)	1 (2002)	2	2 (100 %, 0.015)	--		
S553	Below Maxcy's Mills Road	1 (2000)	1	1 (100 %, 0.022)	1 (2000)	1	1 (100 %, 0.42)
--	Above Rt. 17	1 (2002)	2	2 (100)	--		
S550	Below Howe Road	5 (1999-2004)	13	12 (92 %, 0.011-0.096)	4 (2000, 2002-2004)	4	4 (100 %, 0.42-0.62)
Stormflow sampling							
S585	Outlet of Branch Pond	1 (2002)	1	1 (100 %, 0.014)			
S268	Above Dirigo Road	1 (2002)	1	0 (0 %)			
-- (near S569)	Above Rt. 105 (above Choate Brook)	1 (2002)	3	1 (33 %, 0.018)			
--	Above Rt. 17	1 (2002)	2	1 (50 %, 0.013)			
S550	Below Howe Road	2 (2001, 2002)	8	5 (63 %, 0.020-0.091)			

Maine DEP biologists sampled the macroinvertebrate community in the West Branch Sheepscot River every year between 1995 and 2004 to determine whether aquatic life criteria were met (Davies et al. 1999; L. Tsomides, MDEP, pers. comm.). Sampling results indicate that the community met Class A criteria in seven out of ten sampling events, but did not meet criteria in three events (Table 5). Non-attainment of Class A criteria was likely due to natural variation in community composition (L. Tsomides, MDEP, pers. comm.). Biologists have also sampled algal assemblages at five stations for up to five years (1999 to 2004) and found that conditions were 'Fair' in all instances (scale Good, Fair, Poor; T. Danielson, MDEP, pers. comm.).

Table 5. Biomonitoring results from MDEP.

Assessment	**Sampling Station**	**Site Location** (upstream to downstream)	**Sampling Result**	**Date Sampled**
Macro-invertebrates	S268	Above Dirigo Rd.	Class A	1995-1999, 2001-2002
			Class B	2000, 2003, 2004
Algae	S585	Outlet of Branch Pond	Fair	1999, 2000
	S268	Above Dirigo Rd.	Fair	1999, 2002-2004
	S569	Above Rt. 105	Fair	1999
	S553	Above Maxcy's Mills Rd.	Fair	2000
	S550	Below Howe Rd.	Fair	2000, 2002-2004

Pollutants of Concern

This TMDL addresses instream constituents that have been identified as likely contributors to the observed DO violations. Elevated nutrient loading and accumulation contributes to the growth of algae which consume oxygen during respiration, depressing DO levels. Nitrogen and phosphorus are the major limiting nutrients for algal growth and are pollutants of concern in the West Branch Sheepscot River. Sediment input can increase nutrient levels in a waterbody and is thus also considered a pollutant of concern.

A watershed model, GWLF, was used to simulate the nonpoint source loading of the pollutants of concern, i.e. nitrogen and phosphorus (ENSR 2005). Maine does not have numeric water quality standards for nutrients so model results were compared to results from two attainment watersheds with a similar landuse pattern.

Impaired Stream Segment and Study Area

Problems with dissolved oxygen (DO) have been documented in the West Branch since 1994 (see Table 2 and App. B), and the river was included in Maine's 1998, 2002, and 2004 303 (d) lists of waters that do not meet State water quality standards. As a potential source for the DO impairment, the 303 (d) list names 'agricultural nonpoint sources'. The listed segment of the West Branch Sheepscot River is a 4-mile stretch of Class AA water from Halls Corner (Rt. 17) to the confluence with the Sheepscot River (Fig. 1). Because monitoring results indicate a violation of DO standards throughout the watershed, the impaired segment covered by this TMDL reaches from the outlet of Branch Pond to the confluence with the Sheepscot River.

Priority Ranking and Listing History

The large numbers of streams listed for nonpoint source pollution on the 303(d) list requires Maine to set priority rankings based on a variety of factors. Factors include the severity of degradation, the time duration of the impairment, and the opportunities for remediation. Maine has set priority rankings for 303(d) listed streams by TMDL completion date, and has designated the West Branch Sheepscot River for completion in 2008.

Atmospheric Deposition

Atmospheric deposition of nutrients that fall within a watershed will reach a stream through runoff from land deposited material, and direct contact with rain and dry airborne material that settles on the stream surface. It is assumed that the soil buffers and adsorbs most atmospherically deposited nutrients before they reach the stream through the runoff processes (except in watersheds sensitive to acidification). Regionally, our knowledge of atmospheric deposition of nutrients and sediment in flowing freshwaters is relatively limited.

Natural Background Levels

The West Branch Sheepscot River is statutory Class AA and no reaches were found that consistently attained DO standards[1]. As is true of all watersheds with a history of human habitation, it is not pristine and nonpoint source loading has resulted from human-related activities prior to the 1990s. Halstead (2003) discusses the historical development of the watershed since 1629 and notes various anthropogenic effects on the river. It is difficult to separate natural background from the total nonpoint source load (USEPA 1999) and the information would not add value to the analysis for these TMDLs.

[1] No data are available for the West Branch above Branch Pond.

2. DESCRIPTION OF THE APPLICABLE WATER QUALITY STANDARDS AND NUMERIC WATER QUALITY TARGET

Maine State Water Quality Standard

Water quality standards and water quality classification of all surface waters of the State of Maine have been established by the Maine Legislature (Title 38 MRSA 464-467). According to Maine's Water Classification Program, the West Branch Sheepscot River below Branch Pond is classified as Class AA. As such, the West Branch is required to have an aquatic life, dissolved oxygen (DO), and bacteria content "as naturally occurs". For the purposes of determining a violation of the water classification standard for DO, the standard for Class B streams, i.e. 7 mg/L, is used here.

Designated Uses and Antidegradation Policy

Maine's Water Classification Program (Title 38 MRSA 464-467) states as designated uses for Class AA waters that "(they) shall be of such quality that they are suitable for the designated uses of drinking water after disinfection; fishing; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; and navigation; and as habitat for fish and other aquatic life." The West Branch Sheepscot River does not attain classification due to pollution from agricultural nonpoint sources (MDEP 2002, 2004).

Maine's anti-degradation policy requires that "existing in-stream water uses and the level of water quality necessary to sustain those uses, must be maintained and protected." MDEP must consider aquatic life, wildlife, recreational use, and social significance when determining "existing uses".

Numeric Water Quality Target

Numeric nutrient and sediment targets were established by comparing the West Branch Sheepscot River to two watersheds that attain water quality criteria; these watersheds will be referred to here as 'attainment watersheds'. This approach was chosen since Maine does not have numeric standards for the pollutants of concern. The two attainment watersheds are Footman Brook and Allen Stream in Exeter. Details of stream characteristics can be found in Tetra Tech 2004. These Class A watersheds attain class standards for dissolved oxygen (DO) concentrations (Table 6) and macroinvertebrate communities (MDEP, unpubl. results). They also share similar landuse patterns and soil characteristics with the impaired watershed. Since these streams attain water quality standards, it is assumed that GWLF model results for these streams will provide reasonable targets to achieve DO attainment in the West Branch.

Table 6. Dissolved oxygen (DO) concentrations and temperature data from continuous monitoring in attainment watersheds in August 2005.

Date	DO (mg/L)		Temperature (ºC)	
	Minimum	Maximum	Minimum	Maximum
Footman Brook				
18-Aug	7.9	8.1	19.7	21.4
19-Aug	8.0	9.1	17.6	19.6
20-Aug	7.8	8.3	18.6	20.4
22-Aug	7.8	9.5	16.5	20.7
Allen Stream				
18-Aug	8.3	9.0	16.7	17.8
19-Aug	8.0	9.2	15.9	17.6
20-Aug	7.6	8.5	17.5	18.9
22-Aug	7.7	9.0	16.3	19.3

A comparative approach requires identical modeling procedures be applied to all three watersheds; this is documented in ENSR 2005 for the West Branch and in Tetra Tech 2004 for the attainment streams. Numeric endpoints are derived from modeling results for Total Phosphorus and Total Nitrogen in Footman Brook and Allen Stream as shown in Table 7. Though results were similar for both watersheds, an average of the unit area loads was chosen as the numeric target needed to obtain designated uses in the West Branch.

Table 7. Numeric loading endpoints for pollutants of concern based on GWLF modeling results (Tetra Tech 2004).

Pollutants	Attainment Watersheds		Numeric Target
Annual Unit Area Loads	Footman Brook	Allen Stream	Average for Waterbodies
Phosphorus Load (lb/acre/year)	0.33	0.29	0.31
Nitrogen Load (lb/acre/year)	2.83	2.97	2.90
Sediment Load (t/acre/year)	0.061	0.052	0.057

3. LOADING CAPACITY - LINKING WATER QUALITY AND POLLUTANT SOURCES

Loading Capacity and Linking Pollutant Loading to a Numeric Target

The loading capacity is the mass, of constituent pollutants, that the West Branch Sheepscot River can receive over time and still meet numerical water quality targets. Loading capacity is expressed as an annual load rather than a daily load to normalize the spatial and temporal variation associated with instream nonpoint source pollutant concentrations. The loading capacity is based on a comparative approach to set the allotment for existing and future nonpoint sources that will ensure support for existing and designated uses. The GWLF model output (ENSR 2005, Tetra Tech 2004) expresses pollutants in terms of instream loads which have been broken down into a unit area basis for comparative purposes. Table 7 lists the loading targets or assimilative capacity for comparisons between the attainment watersheds and the West Branch in subsequent TMDL analysis.

Supporting Documentation - TMDL Approach

The TMDL approach includes measuring various environmental parameters and developing a water quality model to estimate pollutant loadings and reductions that will insure attainment of Maine's water quality standards. The West Branch Sheepscot River TMDL analysis uses the GWLF model to estimate pollutant loadings (ENSR 2005). GWLF is an established midrange modeling tool that uses landuse runoff coefficients, the universal soil loss equations, and rainfall inputs to compute flow and pollutant loads. The model was run for a 12-year period to capture a wide range of hydrologic conditions to account for variations in nutrient and sediment loading over time. To estimate the TMDL reductions needed to attain water quality standards, the GWLF model results are used to calculate the existing load in the West Branch Sheepscot River. GWLF was also used to calculate existing loads in the attainment watersheds, Footman Brook and Allen Stream (Tetra Tech 2004). The difference between the impaired and attainment watersheds is the reduction needed to achieve water quality criteria for all nonpoint source pollutants of concern.

Strengths and Weaknesses

The TMDL uses a GWLF model analysis (Appendix B) of existing and target nutrient loads to compute reductions needed to achieve water quality standards.

Strengths:

- GWLF is an established midrange model that is commonly accepted to calculate pollutant loads in rivers and streams TMDLs
- The GWLF model was created using regional input data to reflect local conditions to the greatest extent possible
- Makes best use of available landuse coverages to estimate nonpoint source loads

- The model was run for a 12-year period to account for a wide range hydrologic conditions between years
- A comparative approach is a reasonable mechanism to establish criteria for pollutants of concern where no regulatory numeric criteria exist

Weaknesses:

- Nutrient concentrations are extremely variable in flowing conditions and difficult to accurately depict
- The GWLF model approach is dependent on GIS based landuse coverages which contain some degree of error.
- Landuse runoff coefficients simplify the complex fluctuations in actual runoff based on erosion and land management practices
- GWLF modeling results were not calibrated to monitoring data, because of insufficient data and additional costs associated with that effort

Critical Conditions

The loading capacity for the West Branch Sheepscot River is set to protect water quality and support uses during critical conditions, which is defined as environmental conditions that induce a stress response in aquatic organisms. Environmentally stressful conditions may occur throughout the year and depend on the biological requirements of the life stage of resident aquatic organisms. Traditionally, summer low flow periods are considered critical for aquatic organisms due the combination of low water velocity, high temperatures, and low dissolved oxygen. All aquatic organisms that reside in the stream confront harsh winter conditions and winter often determines the success or failure of native salmonid species, such as brook trout, which have been observed in the West Branch. Seasonally low flows occur in the winter and native fish are under stress as they compete for limited winter habitat, as defined by water velocity and unembedded substrate. Additionally trout eggs are incubating in the gravel during the winter and have specific velocity and dissolved oxygen requirements that may be compromised by the addition of smothering sediment. Some species of stoneflies emerge and develop during the winter and remain vulnerable to chronic sediment. Critical condition is complex in flowing water and a major consideration in using an average annual load approach for these nonpoint source TMDLs.

Critical assumptions used in the GWLF modeling report (ENSR 2005) include:

- The weather data recorded at the Waterville Treatment Plant are assumed to be representative of weather conditions over the West Branch Sheepscot River watershed.
- Septic system failure rates are assumed to be similar to failure rates for rural communities in upstate New York in 1990.
- Values for parameters reported in the GWLF Manual are assumed to be representative of conditions in the West Branch Sheepscot River watershed.
- Nutrient loading parameters for grasslands were assumed to be representative of nutrient loading from dairy farm operations.

TMDL Loading Calculations

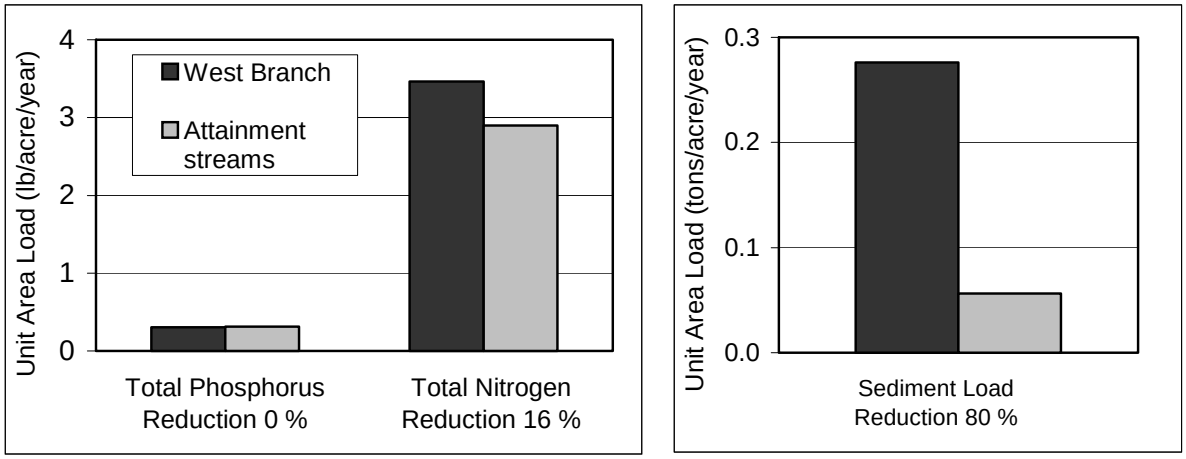
The existing loads for nutrients and sediments in the impaired segment of the West Branch Sheepscot River are listed in Table 8. The modeling reports for the West Branch Sheepscot River (ENSR 2005) and attainment watersheds (Tetra Tech 2004) describe the GWLF modeling results and calculations used in Tables 8 and 9 to define TMDL reductions. An annual time frame provides a mechanism to address the daily and seasonal variability associated with nonpoint source loads. As previously mentioned, it was not possible to separate natural background from nonpoint pollution sources in this watershed because of the limited and general nature of the available information.

Table 8 also compares these existing nutrient and sediment loads in the West Branch Sheepscot River to TMDL endpoints derived from the attainment streams and listed in Table 7. Figure 5 graphically compares the results between the watersheds and estimates of the reductions needed to achieve compliance with Maine's Class AA water quality standards in the impaired stream segment. The percent reductions will be applied to load and waste load allocations.

Table 8. Existing pollutant loads in the West Branch Sheepscot River compared to TMDL load allocations, and the percent reductions required to achieve Class AA water quality standards (as measured by attainment of Class B standards).

TMDL Pollutant Loads **Annual Unit Area Loads**	**Existing Loads in West Branch Sheepscot River**	**Numeric Target from Attainment Streams**	**TMDL % Reductions**
Phosphorus Load (lb/acre/year)	0.30	0.31	0 %
Nitrogen Load (lb/acre/year)	3.46	2.90	16 %
Sediment Load (t/acre/year)	0.276	0.057	80 %

Figure 5. Nutrient and sediment load estimates compared between the watersheds, and reductions needed to achieve compliance with Maine's Class AA water quality standards in the impaired stream segment.



4. LOAD ALLOCATIONS (LAs)

The load allocation (LA) for each of the candidate pollutants in the West Branch Sheepscot River are listed in Table 9. On an annual basis, the LA represents the stream's assimilative capacity allocated to only nonpoint sources of nutrients and sediments. All pollutant sources in these calculations are assigned LAs, representing nonpoint sources from anthropogenic activities including roadways and agricultural inputs for which there are no associated discharge or general permits. The reported LAs represent all the sites within the impaired stream segment that is downstream of Branch Pond, Figure 1.

5. WASTE LOAD ALLOCATIONS (WLAs)

No portion of the West Branch Sheepscot River watershed is regulated under Maine's National Pollutant Discharge Elimination System (NPDES). Therefore the waste load allocation is defined as '0' for all the pollutants of concern in the existing runoff.

Table 9. Load Allocations and Waste Load Allocations for pollutants in the TMDL.

TMDL= LA +WLA	Nutrient load (lb/acre/year)	
	Phosphorus	Nitrogen
Load Allocations (LA)	0.31	2.90
Waste Load Allocations (WLA)	0	0
Loading Capacity (TMDL)	0.31	2.90

6. MARGIN OF SAFETY

An implicit margin of safety was incorporated into the West Branch Sheepscot River TMDL through the conservative selection of the numeric water quality target. In the absence of established regulatory targets, setting water quality targets using the attainment streams approach is a reasonable technique to insure that Class AA water quality standards are attained. Pollutants of concern were modeled individually to provide an implicit margin of safety, which represents a conservative modeling assumption. This TMDL is based on the GWLF modeling output (ENSR 2005), which has a conservative set of assumptions built into the model components.

7. SEASONAL VARIATION

Seasonal variation is considered in the allowable annual loads of nutrients which protect stream biota under the influence of seasonal fluctuations in environmental conditions such as flow, rainfall, and runoff. All unregulated streams in Maine experience seasonal fluctuations in flow, which influences the concentration of nutrients. Typically high flows occur during spring and fall, and low flows during summer and winter. Snow and rainfall runoff may contribute variable amounts of nutrients, while large volumes of runoff may also dilute instream nutrients, depending on the source.

8. MONITORING PLAN FOR TMDLS DEVELOPED UNDER THE PHASED APPROACH

Addressing the problems described in the TMDL will require future assessments of individual sites to develop site specific best management practices. Water quality monitoring should continue to gauge effectiveness of any BMPs or engineered design solutions, as recommended in the 'Implementation Plans' section. As restoration plans proceed, Maine DEP will check on the progress towards attainment of Maine's Class AA water quality standards for DO with deployment of data sondes and aqueous samples for nutrient analysis.

9. IMPLEMENTATION PLANS AND REASONABLE ASSURANCES

The goal of this TMDL assessment on the West Branch Sheepscot River is to use a midrange water quality model, GWLF (ENSR 2005), to define pollutant loads and set water quality targets that will assure compliance with Maine's water quality standards. The nutrient (Total Nitrogen) and sediment reductions listed in the TMDL Allocations, Table 8, represent an average over the year (given the seasonal variation of runoff and ambient conditions), and demonstrate the need to reduce nitrogen and sediment load as the key to water quality restoration. The load reductions provide a guide for restoration plans and engineered solutions that will lower the pollutant content in runoff reaching the stream.

Watershed Restoration Activities

Nonpoint source pollution sites in the West Branch Sheepscot River watershed are the subject of active restoration projects designed to curtail runoff. Working with MDEP's Watershed Management Division (under the 319 NPS Grant Program), the Kennebec County Soil and Water Conservation District has been installing BMPs and instituting practices to decrease pollutant inputs, especially sediment from road sites (KCSWCD, 2003, 2005a). The BMPs installed since 1999 and those proposed for installation in 2006 (KCSWCD, 2005b) should control a significant number of nutrient and sediment inputs and provide considerable progress towards achieving TMDL targets. In addition to BMP installation, the KCSWCD is currently developing a watershed management plan (Time and Tide RC&D 2004) and providing roads and runoff training to towns within the watershed. The Sheepscot Watershed Council (SRWC) is in the process of developing a comprehensive plan for the Sheepscot River watershed (L. Krajewski, SRWC, pers. comm.). This plan will provide a road map for future action in the watershed as spearheaded by the SRWC. All of these projects have the overall goal of improving water and habitat quality in general, and for Atlantic salmon in particular, within the entire Sheepscot River watershed. The watershed management plan and comprehensive plan are being developed to garner widespread support for projects, and promote future activities.

Recommendations

Reducing nutrient inputs is an important step towards improving dissolved oxygen regimes in the West Branch Sheepscot River, but full attainment of DO standards, if possible, requires a step beyond implementation of standard agricultural BMP's. The West Branch has received anthropogenic assaults over many decades and reversing long term degradation will require planning and effort that include local stewardship, instream restoration, and attention to small chronic problems. A comprehensive watershed approach should look to all potential nutrient/sediment sources which includes the impact of impervious surfaces (roads and roofs) and commercial developments (gravel pits, legacy dumps, auto dealers & recyclers). The watershed management plans that are being developed by the KCSWCD and SRWC may be a good way to identify all pollutant sources.

The integrity of instream habitat is also integral to an effective restoration strategy. Sediment has filled in the rocky substrate in places, and the channel morphology has been altered, in some cases producing deadwater areas that are prone to have low dissolved oxygen concentrations. These problem conditions are partly attributable to the many road crossings in the watershed but also sometimes related to long-standing agricultural practices. A geomorphological assessment would disclose channel deficiencies and identify instream restoration opportunities.

Meeting the challenges of restoration in the West Branch Sheepscot River requires the participation of residents of the watershed. One asset to long term restoration is having residents that care about the stream and are actively involved in the restoration process, or an active watershed organization. This watershed is fortunate in having a number of organizations (e.g., Sheepscot Valley Conservation Association, Sheepscot River Watershed Council) and a state agency (KCSWCD) that are actively working with residents and towns to promote watershed projects. Furthermore, because the West Branch is one of Maine's salmon rivers, organizations and agencies concerned with salmon (e.g. US Fish and Wildlife Service, Maine Atlantic Salmon Commission) also have been involved in restoration efforts, generally of a more targeted nature. While typical aquatic restoration efforts do not include local watershed organizing, it should not be overlooked as an important component in improving water quality, particularly in this case.

Recommendation Synopsis

- Continue to identify nonpoint sources (transportation, agricultural, residential) and install BMPs
- Assess instream habitat quality and identify channel restoration opportunities
- Continue to foster local stewardship

10. PUBLIC PARTICIPATION

Public participation in the West Branch Sheepscot River TMDL development is ensured by soliciting reviews of a preliminary review draft TMDL from the following watershed stakeholder organizations:

- Kennebec County Soil and Water Conservation District (Jennifer McLean)
- Sheepscot Valley Conservation Association (Maureen Hoffman, Bethany Atkins)
- Sheepscot River Watershed Council (Levi Krajewski, Brandon Kulik)
- Natural Resources Conservation Service (Don Desrosier)
- Natural Resources Conservation Service (Mary Thompson)
- Maine Atlantic Salmon Commission (Melissa Laser, Paul Christman)
- US Fish and Wildlife (Denise Buckley)
- Towns of Palermo (Lee Jackson, First Selectman), China (Daniel L'Heureux, Town Manager), Windsor (Mary Sabins, Town Manager), Whitefield (Tim Chase, First Selectman)
- BSA Environmental Consulting (Barbara Arter)

Reviews were also solicited from MDEP staff in the Bureau of Land and Water Quality (D. Courtemanch, D. Miller, L. Tsomides, M. Whiting, Division of Environmental Assessment; N. Marcotte, T. St. Peter, Watershed Management Division).

Paper and electronic forms of the *West Branch Sheepscot River TMDL, Draft Report* were made available for public review through several avenues. The report was posted on the Maine DEP Internet Web site and a notice was placed in the 'legal' advertising of local newspapers. The following ad was printed in the Sunday editions of the Kennebec Journal and the Waterville Morning Sentinel on October 2 and 9. It also appeared in the weekly editions of the Lincoln County News and Lincoln County Weekly on October 6 and 13. The U.S. Environmental Protection Agency (Region I) and interested public was provided a 30-day period to respond with draft comments (September 30, 2005 through October 31, 2005).

PUBLIC NOTICE FOR the WEST BRANCH SHEEPSCOT RIVER - In accordance with Section 303(d) of the Clean Water Act, and implementation regulations in 40 CFR Part 130, the Maine Department of Environmental Protection has prepared a Total Maximum Daily Load (TMDL) report (DEPLW0725) for impaired water quality in the West Branch Sheepscot River, located in China, Windsor (Kennebec County), and Whitefield (Lincoln County). This TMDL report estimates nonpoint source loadings of nutrients and sediment, and the reductions needed to restore the stream to meet Maine's Water Quality Criteria.

A Public Review draft of the report may be viewed at the Maine DEP Offices in Augusta (Ray Building, Hospital St., Rt. 9) or on-line at: http://www.maine.gov/dep/blwq/comment.htm.

Send all written comments by October 31, 2005, to Melissa Evers, Stream TMDLs, Maine DEP, State House Station #17, Augusta ME 04333 or email: melissa.evers@maine.gov

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